Comment on "Experimental Evidence for Dynamical Decay of Finite Nuclear Matter"

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In an interesting experimental paper [1], Yanez *et al.* studied the isotropic and "neck" emission of intermediate mass fragments associated with fission in the reaction $^{12}C+^{232}Th$. On the basis of the charge distribution and excitation functions of the two components, the conclusion is reached that the isotropic component is "statistical", while the "neck" component is "dynamical". We will show here that both components are consistent with statistical emission.

Before dealing with the subject, let us dispose of a preliminary triviality. We accept as statistical not only those evaporation processes that are associated with fully equilibrated systems, but also those associated with "slowly developing" collective modes. In this sense, "neck emission" involving a nonstationary shape, does not preclude *a priori* statistical emission.

The statistical emission probability of a fragment with barrier B_Z can be written as $P_Z = \Gamma_Z/\Gamma_T \cong \rho_Z/\Sigma\rho$. Relative probabilities, referred to $Z = 3$, are: $P_Z/P_3 \propto K(Z)\exp(-(B_Z - B_3)/T)$, where B represents the barriers and T the temperature. From these simple expressions we can draw several interesting conclusions.

a) The probabilities depend on B_Z/T. For *a given* B_Z distribution it is true that the higher the temperature, the flatter the yield distribution. But a flatter yield distribution can simply arise from a different, flatter barrier distribution at the same or even smaller temperature.

b) For the reason given above, a flat yield distribution at constant T implies that the barrier distribution is *flat*, constant with Z, *not* that the barriers are *zero*.

c) Similarly, the *relative excitation functions* can rise, be flat or decrease with excitation energy. In particular, if the barrier of the chosen Z value is *equal* to that of $Z = 3$, the relative excitation function must be flat; if it is *lower* than that of $Z = 3$, the excitation function *decreases* with increasing excitation energy.

In the case of isotropic emission the rising relative excitation functions indicate that the barriers increase with Z. In the case of neck emission they indicate a constant barrier up to to $Z = 7$ and then a lower barrier for $Z = 8 - 13$.

The actual shapes of the excitation functions both for isotropic and neck emissions are also quite consistent with statistical assumptions. To visualize this let us write the relative probabilities as

$$\ln(P_Z/P_3) = A(Z) - \Delta B/T = A(Z) - \sqrt{a/E^*}\Delta B \quad (1)$$

where $\Delta B = (B_Z - B_3)$, and plot the left hand side *vs* $\sqrt{a/E^*}$. The resulting plots, shown in Fig.1, are reasonably linear, both for isotropic and neck emission. In other words both classes of excitation functions are *equally consistent with statistical assumptions*.

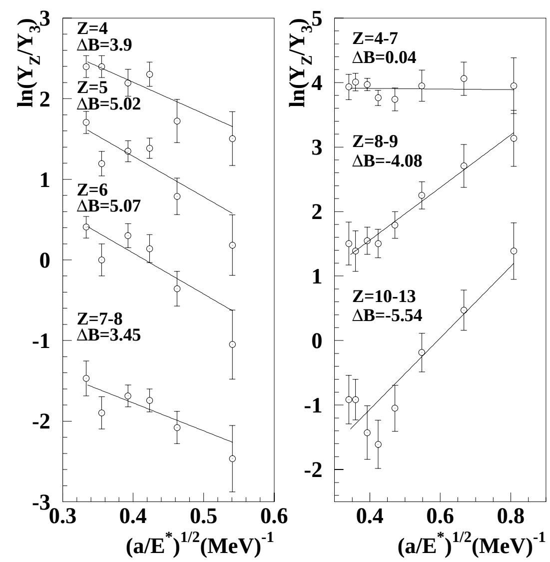

FIG. 1. Left: isotropic emission; right: neck emission. The data are taken from [1]. The lines represent linear fits with Eq. 1.

This is to be contrasted with the claim that, in the case of neck emission "this behavior is inconsistent even with a zero emission barrier scenario and is a strong indication of a nonstatistical, dynamical origin ..."

From the slopes of the plots in Fig. 1 the very important quantities ΔB can be obtained. They are deduced assuming $a = A/9$ and they are written near the corresponding plots. In the case of isotropic emission the quantities are positive and qualitatively consistent with the increasing barriers calculated from a liquid drop model.

In the case of neck emission, the quantity ΔB for $Z = 4 - 7$ is nearly zero, and negative for $Z = 8 - 13$. In a statistical picture this suggests that the neck is thick for $Z = 3 - 7$, the barrier being the energy necessary to create the extra surface in the two cuts required to break the fragment loose. In contrast, for $Z = 8-13$ the neck is long and *thin* and the two cuts are less energy expensive.

Thus, the exciting new data on neck emission of Yanez *at al.* coupled with this kind of analysis may lead to valuable information unavailable heretofore on the emission barriers and the shape associated with ternary fission.

[1] Yanez *et al.*, Phys. Rev. Lett. **82**, 3585, (1999).